M.TECH – AUTOMOTIVE SYSTEMS

Department of Mechanical Engineering

High competition and large market size are characteristic of the automotive industry. The Automotive Industry is poised to emerge as the most important economic sector for the next ten years and automotive electronics is expected to play a major role in mitigating industry challenges. The cost of the electronic embedded system in an automobile has increase from a mere one percent in 1980 to twenty percent in 2005 and would be forty percent by 2015. Microcontrollers, embedded systems, a variety of sensors, and many challenging on-line processing techniques contribute substantially to improve engine performance, redefine engine safety, passenger comfort, driver interface, navigation and environmental pollution. India, with its emerging market and competent professionals – has become a hub of development activity in the area.

The need to train and evolve professionals with expertise in digital electronics and allied areas has become a challenging task. The proposed course here is expected to fill the gap. It is expected to offer subjects in electrical sciences with a judicious mix of those in automotive systems. Those completing the course are expected to be well suited to take up the R & D challenges in the area in the decades to come and would be equipped to work effectively in collaboration with a multidisciplinary team.

CURRICULUM
First Semester

Course Code	Type	Course	L	T	P	Cr
AS601	FC	Applied Mathematics	3	0	0	3
AS602	FC	Object-oriented Software Analysis and Design with UML	3	0	0	3
AS603	FC	Foundations of Embedded and Real-time Operating Systems (RTOS)	3	0	0	3
AS604	FC	Introduction to Digital Signal Processing (DSP)	3	0	0	3
AS611	SC	Introduction to Automotive Systems	3	0	0	3
HU601	HU	Cultural Education*				P/F
					Credits	**15**

*Non Credit Course

Second Semester

Course Code	Type	Course	L	T	P	Cr
AS612	SC	Emerging Computer Architectures	3	0	0	3
AS613	SC	Embedded DSP Architectures with Focus on TI DSP Processors	3	0	0	3
AS614	SC	Introduction to Multimedia Systems	3	0	0	3
AS615	SC	Wireless Networks	3	0	0	3
AS616	SC	Embedded Processors and Interfacing with Focus on ARM Processors	3	0	0	3
AS619	SC	Seminar -1	0	0	1	1
	E	Elective I	3	0	0	3
					Credits	1**9**

Third Semester

Course Code	Type	Course	L	T	P	Cr
AS617	SC	Emerging Applications and Platforms in Embedded Systems	3	0	0	3
AS618	SC	Embedded Systems on Chip (SOC), Fault Tolerance, Verification and Testing	3	0	0	3
	E	Elective II	3	0	0	3
	E	Elective III	3	0	0	3
	E	Elective IV	3	0	0	3
AS620	SC	Seminar -2	0	0	1	1
AS798	P	Dissertation				4
						Credits **20**

Fourth Semester

Course Code	Type	Course	L	T	P	Cr
AS799	P	Dissertation				10
						Credits **10**

Total Credits: 64

List of Courses

Foundation Core

Course Code	Course	L	T	P	Cr
AS601	Applied Mathematics	3	0	0	3
AS602	Object-oriented Software Analysis and Design with UML	3	0	0	3
AS603	Foundations of Embedded and Real-time Operating Systems (RTOS)	3	0	0	3
AS604	Introduction to Digital Signal Processing (DSP)	3	0	0	3

Subject Core

Course Code	Course	L	T	P	Cr
AS611	Introduction to Automotive Systems	3	0	0	3
AS612	Emerging Computer Architectures	3	0	0	3
AS613	Embedded DSP Architectures with Focus on TI DSP Processors	3	0	0	3
AS614	Introduction to Multimedia Systems	3	0	0	3
AS615	Wireless Networks	3	0	0	3
AS616	Embedded Processors and Interfacing with Focus on ARM Processors	3	0	0	3
AS617	Emerging Applications and Platforms in Embedded Systems	3	0	0	3
AS618	Embedded Systems on Chip (SOC), Fault Tolerance, Verification and Testing	3	0	0	3
AS619	Seminar -1	0	0	1	1
AS620	Seminar -2	0	0	1	1

Electives

Course Code	Course	L	T	P	Cr
Elective I					
AS701	Automotive Chassis and Suspension system	3	0	0	3
AT701	Automotive Standards and Regulations	3	0	0	3
AS702	Programming Multicore Architectures	3	0	0	3
Elective II					
AT705	Automotive Safety	3	0	0	3
AS703	Introduction to Automotive Embedded Systems	3	0	0	3
AT707	CAE for Automotive Applications	3	0	0	3
Elective III					
AT713	Alternate Propulsion Technology	3	0	0	3
AS704	Advanced Automotive Embedded Systems	3	0	0	3
AT710	Automotive HVAC, Cabin Comfort and Ergonomics	3	0	0	3
Elective IV					
AS705	NVH and Refinement for Automotive Application	3	0	0	3
AT614	Automotive Emissions and Control	3	0	0	3
AS706	Automotive Infotainment	3	0	0	3

Project Work

Course Code	Course	L T P	Cr
AS798	Dissertation		4
AS799	Dissertation		10

AS601 APPLIED MATHEMATICS 3-0-0-3

Z-Transforms and its applications: Z-transforms – Properties of the region of convergence – Inverse z-transforms – z-transform properties – Solving differential equations using z transform.

Wave Equation: Solution of initial and boundary value problems–Characteristics – D'Alembert's solution – Significance of characteristic curves – Laplace transform solutions for displacement in a long string, in a long string under its weight – a bar with prescribed force on one end – Free vibrations of a string.

Probability and Random Variables: Probability concepts – Random variables – Moment generating function – Standard distributions – Two-dimensional random variables – Transformation of random variables – Correlation and regression.

Queuing theory: Single and Multiple server Markovian Queuing Models with finite and infinite system capacity – Priority queues – Queuing applications.

TEXT BOOKS/REF*E*RENCES:

1. Robert Vich, "*Z Transform Theory and Applications*", Fourth Edition, McGraw-Hill, 2002.
2. Robert D.Strum, *"Z Transform and Its Applications",* Prentice Hall, 2002.
3. Athanasios Papoulis, "*Probability, Random Variables and Stochastic Processes*", Third Edition, McGraw-Hill, 1991.
4. David C. Lay, "*Linear Algebra and Its Applications*", Fourth Edition update, Addison-Wesley, 2012.
5. Jaan Kiusalaas, "*Numerical Methods in Engineering with MATLAB*", Second Edition, Cambridge University Press, 2010.

AS602 OBJECT-ORIENTED SOFTWARE ANALYSIS AND DESIGN WITH UML 3-0-0-3

Object Oriented Principles: Encapsulation - Classes: behaviors and properties - Objects and Object references - Abstract base classes – Interfaces, Object Oriented Principles: Classes and Relationship – Inheritance –Polymorphism - Interface and implementation – Composition, CRC Card Method: Discovering classes - Selecting core classes - Assigning responsibilities. Unified Modeling Language Tools: Class Diagram - Sequence Diagram - Activity Diagram - State Diagram - Unified Modeling Language Tools - Dynamic Modeling - System Architecture - Deployment Diagrams, Designing Client/Server and Distributed Systems: OMG's CORBA Specification - Interface Definition Language (IDL) - Object request broker (ORB). Miscellaneous: Component model for Software Design - Java Language Features (RMI, Beans, EJB)

TEXT BOOKS/REFERENCES:

Hans-Erik Eriksson and Magnus Penker, "*UML Toolkit (Book + UML CD ROM)"* John Wiley and Sons,1998.

AS603 FOUNDATIONS OF EMBEDDED AND REAL-TIME OPERATING SYSTEMS (RTOS) 3-0-0-3

Introduction: Review of C programming language – standards – libraries - strings – Types – variables – operators - control structures - and functions - Set up embedded environment and tool chains. Data structures: arrays - pointers and pointer manipulation – structs – strings - embedded vs. standard systems. Memory: Memory operations and heap management - finite state machines as design tool - up casting and down casting and void - dynamic allocation and memory leak.

Kernel: Configuring and building a kernel - booting- debugging embedded systems - DDD debugger. Device driver: Introduction to device driver - Design and building a device driver into a kernel - Device structures, operations - kernel tables and dispatching.

Introduction to real-time systems - interrupts and exceptions - interrupt driven systems - polling. Concurrent processing: Introduction to processes, threads and multithreaded programs - critical sections - inter-process communication and synchronization. Scheduling: multi-tasking - deadline driven and rate - monotonic scheduling - Periodic and a-periodic scheduling - priority inversion and priority inheritance. Timing: clock – delays - signals and alarms - sleep and timers - time multiplexing and time-driven design.

Embedded networking: Sockets - embedded web servers - resource virtualization and other application level protocols - Emerging operating systems**:** Eclipse IDE for C - Embedded Linux Pthreads - Gnu Tool chain - UML design tool.

TEXT BOOKS/REFERENCES:

1. Labrosse,J.J., "*MicroC/OS-II: The Real-Time Kernel*", Second Edition, Newnes, 2002.
2. Herman B, "*Real-Time and Embedded Guide*", Fourth Edition, Herman Bruyninckx Publication, 2002.

AS 604 INTRODUCTION TO DIGITAL SIGNAL PROCESSING (DSP) 3-0-0-3

Review of signals and systems: Commonly used signals in DSP- unit step and Impulse, sinusoids, complex exponentials, classification of signals, periodicity, energy vs power signals.
Discrete time systems – classification of discrete systems, Characterization of LTI systems - Impulse response, convolution, difference equation, FIR/IIR systems. Basic concepts of sampling.
Review of Fourier analysis: Continuous time periodic Fourier series; discrete time periodic Fourier series; Continuous time A periodic Fourier transform; discrete time A periodic Fourier transforms; Discrete Fourier Transform and Fast Fourier transforms.
Definition of DFT; Properties and relationships among various Fourier transforms. The discrete Fourier transforms; definition of the DFT and its inverse; transform relationships; cyclic convolution and correlation; Fast Fourier transform algorithms, Linear filtering of long sequences using the FFT.
Z-Transforms: Definition, ROC, properties relationships to DTFT and D FT, concepts of poles and zeros of a system, inverse Z-transforms.
Digital Filter structures: FIR Filter Structures- direct, cascaded and parallel form IIR Filter structure - Lattice form. Introduction to Filters**:** Introductory concepts to Analog and Digital filters.

TEXT BOOKS/REFERENCES:

1. Sanjit K Mitra, "*Digital Signal Processing, A Computer Based Approach* '', Third Edition, Tata McGraw Hill, 2005.
2. Proakis.J.G. and Manolakis. D.G., "*Digital Signal Processing: Principles, Algorithms and Applications"*, Fourth Edition, Pearson, 2007.
3. Simon Haykin, "*Adaptive Filter Theory*", Prentice Hall, 1997.
4. Ifeachor E. C. and Jervis B. W., "*Digital Signal Processing: A Practical Approach*", Second Edition, Addison Wesley, 2002.
5. Steven W Smith, "*The Scientist and Engineer's Guide to DSP*", Newnes, 1997

AS611 INTRODUCTION TO AUTOMOTIVE SYSTEMS 3- 0- 0- 3

Internal combustion engines – ideal cycles –actual cycles – reciprocating piston engines - operating principles- mixture formation – combustion – emissions – charge cycle and supercharging – Exhaust gas recirculation – engine cooling – Air filtration – exhaust systems – regulations – Exhaust gas measuring techniques

Drive train – drive train elements – Multi-speed gearbox – Manual Transmission- Automatic transmissions – continuously variable transmissions- all wheel drive

Chassis systems – Basic principles – Suspension – shock absorbers – Wheels – wheel suspensions – Tires – Steering, system requirements - power assisted steering systems

Brakes – Principle – regulations – Wheel brakes – disk, drum brakes – brake system for passenger cars – electro hydraulic brake – brake fluids

Vehicle dynamics – dynamics of linear motion – accelerating and braking –dynamics of lateral motion –operating dynamics – Aerodynamic parameters

Vehicle acoustics – exterior noise measurement and statutory limits – engineering acoustics

TEXT BOOKS/REFERENCES:

1. Heywood J B, "*Internal Combustion Engine Fundamentals*", McGraw Hill International, 1993.
2. Halderman, "*Automotive Chassis Systems*", Fifth Edition, Prentice Hall, 2008.
3. Rudolf Limpert, "*Brake Design and Safety*", Second Edition, SAE Publication, 1999.
4. Xu Wang, "*Vehicle Noise and Vibration Refinement*", CRC Press Publication, 2010.

AS612 EMERGING COMPUTER ARCHITECTURES 3-0-0-3

Introduction: Technology trends affecting emerging architectures - Review of Computer Architecture Basics: RISC instruction set architectures - Multi-cycle data path and pipelining - Memory and memory hierarchies - General purpose multi-core architectures: Synchronization primitives - Shared memory - Vector processing (SIMD) - Programming paradigms - Multicore DSP and System on Chip architectures : Cradle Technologies - IBM Cell - Programming Cell - Multicore Graphics architectures: nVidia CUDA - Programming GPUs - Software configurable architectures : Tensilica- Stretch

TEXT BOOKS/REFERENCES:

1. J. L. Hennessy and D. A. Patterson, "*Computer Architecture: A Quantitative Approach*", Fourth Edition, Morgan Kaufmann, 2006.
2. J. Šilc, B. Robic and T. Ungerer, "*Processor Architecture: From Dataflow to Superscalar and Beyond* "Fourth Edition, Springer, 1999.
3. D. A. Patterson and J. L. Hennessy, "*Computer Organization and Design: The Hardware/Software Interface*", Fourth Edition, Elsevier, 2008.

AS613 EMBEDDED DSP ARCHITECTURES WITH FOCUS ON TI DSP PROCESSORS 3-0-0-3

General purpose microprocessors – Architectural optimizations for a DSP Specific applications of DSP processors – Pipelined Architecture – Looping Hardware Units – Accumulator and Multipliers : Parallel operation – Data path unit – Floating Point Unit – SIMD architecture flow – DMA operations – ADC and DAC environment processes – Memory – Harvard and Von-neumann architecture – Address Calculations Unit – Saturation point and Fixed point Data operations – Instruction set - Multiply and Accumulate – SIMD – VLIW - Superscalar architectures – Introduction - Features and Internal Architecture of Texas Instruments TMS320C6X DSP - Memory Architecture - Addressing modes - Pipelined operation and Programming - Recent Trends in DSP's - Prerequisites: Knowledge of Conventional Microprocessor/Microcontroller Architecture.

TEXT BOOKS/REFERENCES:

1. Texas Instruments *"TMS320C6000 Technical Brief*" document and "*TMS320C6201 Fixed-Point Digital Signal Processor"* data sheet.
2. Texas Instruments "*TMS320C6701 Floating-point Digital Signal Processor*" data sheet.
3. Phil Lapsley, *"DSP Processor Fundamentals: Architecture and Features***,** Berkely Design Technology, 1996.
4. Dake Liu, "*Embedded DSP Processor Design* (*Volume* 2)*"*, Morgan Kaufmann, 2008.
5. B. Venkataramani and M. Bhaskar, ''*Digital Signal Processors-Architecture, Programming and Applications"*, Tata McGraw Hill, 2002.

AS614 INTRODUCTION TO MULTIMEDIA SYSTEMS 3-0-0-3

Introduction and Fundamentals in Multimedia -Graphics and Image Representation - Fundamentals in Audio and Video - Lossless Compression - Loss Compression - Fourier and DCT Transforms. Image and Video Coding Standards - Image Compression Basics - Video Compression Basics - MPEG-1, MPEG-2, MPEG-4 and H.264 - Basic Audio Compression - MPEG Audio. Multimedia Communication and Networking - Data Communication and Networking - Multimedia Networking Basics - Multimedia Communications Basics
Multimedia over Wireless Networks.

TEXT BOOKS/REFERENCES:

1. Ralf Steinmetz and Klara Nahrstedt, "*Introduction to Multimedia Systems",* Springer, 2004.
2. Gaurav Bhatnager, and Shikha Mehta Sugata Mitra *"Introduction to Multimedia Systems*", Academic Press, 2002.

AS615 WIRELESS NETWORKS 3-0-0-3

Overview of basic principles in computer networks and wireless networks - power aware computing - integration of these principles into embedded systems - basic security principles as applied to this context - Computer Networks review - Wireless networks review - Power-aware computing - Sensor networks - Applications in embedded systems - Integration of wireless, sensors and embedded hardware/software - Security.

TEXT BOOKS/REFERENCES:

1. Jochen Schiller, "*Mobile Communications*", Second Edition, Pearson Education, 2003.
2. X.Wang and H.V.Poor, "*Wireless Communication Systems",* Pearson Education, 2004.
3. M.Mallick, "*Mobile and Wireless Design Essentials*", Wiley Publishing Inc., 2003.
4. P.Nicopolitidis, M.S.Obaidat, G.I. Papadimitria and A.S. Pomportsis, "*Wireless Networks*", John Wiley & Sons, 2003

AS 616 EMBEDDED PROCESSORS AND INTERFACING WITH FOCUS ON ARM PROCESSORS 3-0-0-3

An advanced course in microprocessors and interfacing: 8-64 bit processors -Intel Pentium Processor - PowerPC - Arm/Strong Arm◊ Intel Xscale - MIPS - SuperH, - IBM and Intel Network Processors - Microprocessors and microcontrollers - ARM processor architecture - programming - Amba interface for Parallel and serial I/O - interrupts - Current processors for embedded applications .

TEXT BOOKS/REFERENCES:

1. Jochen Steve Furber, "*ARM System-on-Chip Architecture*", Second Edition, Addison Wesley Trade Computer Publications, 2000.
2. Andrew Sloss, Dominic Symes and Chris Wright, "*ARM System Developers Guide*", Third Edition, Elsevier, 2004.

AS617 EMERGING APPLICATIONS AND PLATFORMS IN EMBEDDED SYSTEMS 3-0-0-3

Introduction to mobile phone programming: Building effective interfaces for mobile devices with 3D - SVG and games API - Mobile phone programming languages - Internationalizing API. Creating end to end mobile applications: payment API - Python for Symbian phones - C++ for Symbian phones.

Java Micro Edition: Netbeans IDE - The Mobile Information Device Profile and Connected Device Limited Connection - Mobile services architecture - Microsoft Windows CE.net - Visual Studio .net and C# - Peer-to-Peer file sharing for mobile devices. Convergence of mobile phone network and sensor network.

Emerging RTOS Requirements : support for IP, multimedia, memory and resource protection and GUI - Metrics in Real-Time Systems - End-to-end latency – Jitter - maintainability - survivability - dynamism and adaptability.

Real-Time Operating System standards: IEEE 1003.1b POSIX Real-Time Extensions - OSEK automotive real-time OS standard – Miscellaneous: Perl scripting language, RFID devices, and sensors networks.

TEXT BOOKS/REFERENCES:

1. Daniel Sanches and Crespo Dalmau, "*Core Techniques and Algorithms in Game Programming*", New Riders Publishing, 2003.
2. Jon S. Wilson, "*Sensor Technology Handbook*", Newnes, 2004.
3. Tomas Akenine-Moller, Eric Haines and, AK Peters "*Real- Time Rendering*", Third Edition, CRC Press, 2011.

AS618 EMBEDDED SYSTEMS ON CHIP (SOC), FAULT TOLERANCE, VERIFICATION AND TESTING 3-0-0-3

Design, verification and testing of today's system on chips. System design challenges, design verification, test and debug standards. Both hardware and software issues related to design, test and fault tolerance will be covered with special emphasis on power management. Projects - hardware or software systems.

Introduction to Embedded hardware - Processors, Chipsets, Cores - System on Chip basic concepts - System level design and integration with emphasis - power, performance - test and verification - Hardware/Software Co Design - Verification methodologies - Application driven embedded SoC systems - SoC test and test scheduling - Fault Tolerance and IP protection .

TEXT BOOKS/REFERENCES:

1. Frank Vahid and Tony D. Givargis, "*Embedded System Design* : *A Unified Hardware/Software Introduction"* John Wiley, 2001
2. Jason Andrews, "*Co-verification of Hardware and Software for ARM SoC Design (Embedded Technology)",* Newnes, 2005

AS701 AUTOMOTIVE CHASSIS AND SUSPENSION SYSTEM 3-0-0-3

Tires and Wheels - Tire Pressure Monitoring Systems - Tire and Wheel Service System Components and Operation, Braking System: Principles, Components and Performance Standards. Hydraulic Systems, Brake Fluid and Lines – Bleeding, - Drum and Disc Brakes - Diagnosis and Service. Parking Brake System - Power Brake System - Regenerative Braking Systems, ABS Components and Operation - Electronic Stability Control Systems, Front and rear suspension - Electronic Suspension Systems, Steering systems - Columns and Gears - Steering Linkage - Power-Assisted Steering Operation, Drive Axle Shafts and CV Joints, Wheel Alignment Principles - Diagnosis and Service, Design features and standards of chassis systems.

TEXT BOOKS/REFERENCES:

1. Halderman, "*Automotive Chassis Systems*", Fifth Edition, Prentice Hall, 2008.
2. Genta, Giancarlo and Morello L, "*The Automotive Chassis Vol 1 - Component Design*", Springer, 2009.
3. Genta, Giancarlo and Morello L, "*The Automotive Chassis Vol 2 - System Design*", Springer, 2009.

AT701 AUTOMOTIVE STANDARDS AND REGULATIONS 3- 0- 0- 3

Difference between standards and regulations. Types of standards - Company, national and international standards. SAE recommendations – BIS standards – ISO standards. Automotive Industry Standards (AIS) - Mechanism of standards making in India. Regulations – Central Motor Vehicle Rules (CMVR) – EEC/ECE/EC regulations - EPA/NHSTA regulations. Type Approval of Vehicles in India and their procedures. WP29 and International harmonization of standards in transportation engineering

TEXT BOOKS/REFERENCES:

1. SAE Handbooks, 2009.
2. ISO Standards, 2010.
3. EEC/ECE/EC Regulations, 2011.
4. EPA/NHSTA Regulations, 2011.
5 CMVR Type Approval Hand book, 2010.

AS702 PROGRAMMING MULTI-CORE ARCHITECTURES 3-0-0-3

Introduction - Technology trends leading to prevalence of multi-core architectures - General purpose multi-core architectures - Shared memory architecture - Synchronization primitives - Vector processing (SIMD).

Multi-thread programming using Pthreads - Programming using vector instructions – SSE2 - Programming using OpenMP - Programming using MPI - IBM Cell (PS3) Programming - Cell architecture - Programming.

Graphics processor programming – nVidia CUDA - nVidia CUDA architecture - programming - Power-aware computing.

TEXT BOOKS/REFERENCES:

1. David Kirk and Wen-mei Hwu, "*Programming Massively Parallel Processors, A Hands-on Approach*", Morgan Kaufmann, 2010.
2. Jason Sanders and Edward Kandrot, "*CUDA by Example: An Introduction to General - Purpose GPU Programming*", Addison-Wesley Professional, 2010.

AT705 AUTOMOTIVE SAFETY 3- 0- 0- 3

Statistics of accidents - Accident investigation and analysis. Active and passive safety. Characteristics of vehicle structures, Optimization of vehicle structures for crash worthiness. Types of crash / roll over, Regulatory requirements for crash testing - Instrumentation, high speed photography, Image Analysis – Crash analysis using appropriate software. Pedestrian Safety and Ergonomics - Anthropometry - Locations of controls. Human impact tolerance- Determination of Injury thresholds, Severity Index, Study of comparative tolerance. Study of crash dummies using appropriate software. Vehicle Safety systems - Survival space requirements, Restraint systems used in automobiles - Safety belts, Head restraints, Air bags - Use of energy absorbing systems - Impact protection from steering controls.

Design of seats - Damageability criteria in bumper designs - safety glass and their requirements, rearward field of vision in automobiles - Warning devices- Collision warning and avoidance systems. Comfort and convenient systems. Automotive Lighting and Light Signaling Devices - design, construction, material, and performance - Light signaling devices - Emerging technologies: Gas Discharge lamp, LED, Adoptive Front Lighting System, Daylight Running Lamps.

TEXT BOOKS/REFERENCES:

1. Johnson W and Mamalis A.G., "*Crashworthiness of Vehicles*", Mechanical Engineering Publications, 2002.
2. Olson L. P., *"Forensic Aspects of Driver Perception and Response*", Lawyers and Judges, 1996.
3. Daniel J Helt, "*Recent Development in Automotive Safety Technology*", SAE International Publication, 2009.
4. Robert Bosch, "*Safety Comfort and Convenience Systems*", Wiley, 2008.
5. Richard Bishop, "*Intelligent Vehicle Technology and Trends*", Artech House, 2005.

AS703 INTRODUCTION TO AUTOMOTIVE EMBEDDED SYSTEM S 3-0-0-3

Automotive Power Train Sub- Systems: Air System, Fuel System (Carburettor & Diesel Fuel Injection, Ignition System, Exhaust System and other Auxiliary Systems - Cooling, Lubrications & Electrical Systems), - Need for Electronics in Automotive Systems: Performance, Speed, Power, and Torque, Control - Emission, Fuel Economy, Drivability, and Safety & Legislation - Environmental legislation for pollution & Safety Norms - Overview of Vehicle Electronic Systems: Basic electrical components and their operation in an automobile: Starting systems, Charging systems - Ignition systems – Electronic fuel control – Throttle by wire systems

Engine management systems – Gasoline / Diesel systems, various sensors used in system – System level tests – Software calibration using engine and vehicle dynamometers – Environmental tests for Electronic Control Unit - Application of Control elements and control methodology in Automotive System – on board diagnosis for power train systems - transmission System - Front, Rear & 4 wheel Drive, Manual, Automatic Transmission, Differential - Braking Systems, Steering Systems - Rack and Pinion, Power Steering.

TEXT BOOKS/REFERENCES:

1. Heller's, "*Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics*", Fifth Edition, Nelson Thrones, 2007.
2. William B. Ribbens, "*Understanding Automotive Electronics*", Sixth Edition, Newnes, 2002.
3. Tom Denton, "*Automobile Electrical and Electronic Systems*", Third Edition, Elsevier, 2004.
4. Robert Bosch, "*Bosch Automotive Handbook*", Seventh Edition, Wiley, 2008.
5. Uwe Kiencke and Lars Nielsen, "*Automotive Control Systems: For Engine, Driveline and Vehicle*", Second Edition, Springer, 2005.

AT707 CAE FOR AUTOMOTIVE APPLICATIONS 3-0-0-3

Introduction to modern hardware and computing systems- Networking. Visualization- digital mockup – Virtual reality centers – styling. Finite element methods and their applications to automotive applications. Modeling and simulation of automotive systems such as braking, suspension, hydraulics, fuel, transmission, electrical harness, tubing etc.CAD/CAM/CAE CFD. Vehicle dynamics and simulation. Vehicle crash and occupant protection simulation.
Simulation of engine and subsystems as well as combustion/ Simulation of various control systems/NVH simulation, Vehicle performance simulation. Optimization of the various systems and multi attribute optimization. Meshless computing, Simultaneous and concurrent engineering.

TEXT BOOKS/REFERENCES:

1. H. R. Parsaei and William G. Sullivan, "*Concurrent Engineering: Contemporary Issues and Modern Design Tools*", Springer, 1993.
2. Utpal Roy, "*Simultaneous Engineering: Methodologies and Applications*", Gordon and Breach Science Publishers, 1999.
3. Carl Machover, "*The CAD/CAM Handbook*", McGraw-Hill, 1996
4. Carl Machover, "*The C4 Handbook: CAD, CAM, CAE, CIM*", Tab Professional and Reference Books, 1989.
5. Anderson J D, "*Computational Fluid Dynamics: Basics with Applications*", McGraw Hill, 1995.

AT713 ALTERNATE PROPULSION TECHNOLOGY 3-0-0-3

Use of CNG and LPG in IC engines - their merits and demerits compared to gasoline and diesel. Issues involved and possible solutions. Use of advanced fuels like LNG, Bio diesels, vegetable oils, Hydrogen Cycle, Reversible reactions and chemical equilibrium, Thermodynamics, Reaction Kinetics, Electrochemistry, Organics reactions involving hydrogen, Occurrence, properties and use, Hydrogen as energy carrier, Production & Storage, Transport and Distribution, Hydrogen Technology Assessment, Challenges and Requirements, Hydrogen Engine, Hybrid. Safety Analysis of Hydrogen Vehicles and Infrastructure, State of the Art Portable Applications, Synthesis of Nanoscale Hydrogen Storage Materials. Hydrogen based fuel cells, Proton exchange membrane, solid oxide fuel cells, alkaline fuel cells, Fuel cells system architecture, Electric and hybrid vehicles, Plug-in and fuel cell vehicles. Concepts and terminology, energy conversion and storage options, modeling, analysis, system integration and basic principles of vehicle controls. Advancements in harness of solar energy and photovoltaics. Solar car performance – Solar array design, Aerodynamics of solar cars. Composite materials for solar vehicles, Battery systems, safety, Electrical systems, standards. Energy storage devices and their management.

TEXT BOOKS/REFERENCES:

1. Leon and Aline, "*Hydrogen Technology*", Springer Publications, 2008.
2. T. Nejat Veziroglu and Frano Barbir, "*Hydrogen Energy Technologies*", UNIDO, 1998.
3. Roman J.Press, K.S.V.Santhanam, Massoud J.Miri, Alla V. Bailey and Gerals A.Takacs, "*Introduction to Hydrogen Technology*", Wiley, 2008.
4. Roger Messenger, "*Photovoltaic System Engineering*", CRC Press, 2003.
5. Micheal Boxwell, "*Solar Electricity Handbook*", Greenstream Publishing, 2010.

AS704 ADVANCED AUTOMOTIVE EMBEDDED SYSTEMS 3-0-0-3

Electronics in Automotive chassis systems - Chassis subsystem - ABS, TCS, & ESP – Comfort and safety subsystems- Night Vision, Airbags, Seatbelt Tensioners, Cruise Control- Lane-departure - warning, Parking.

Electronic transmission control – Sensors and actuators - Vehicle safety system – Electronic control of braking and traction – System level tests – Introduction to longitudinal and lateral vehicle control – Modelling and simulation study of ABS – Adaptive Cruise control – Active suspension control – brake by wire – steer by wire systems – on board diagnosis for chassis systems. Vehicle Dynamics: Acceleration Performance, Braking Performance, Road Loads, RIDE, Steady state cornering, Roll Over, Tires. Introduction to body electronics – Sensors and actuators – automotive alarms – lighting – central locking and electric windows – HVAC systems – Electronic control of AC systems – cabin comfort - Active safety and passive safety – optimization of vehicle structures for crash worthiness – crash analysis using appropriate software – Restraint systems used in automobiles – safety belts - Head restraints – Air bags

TEXT BOOKS/REFERENCES:

1. Robert Bosch, "*Safety Comfort and Convenience Systems*", Wiley, 2008.
2. Rajesh Rajamani, "*Vehicle Dynamics and Control*", Springer, 2005.
3. Johnson W and Mamalis A.G., "*Crashworthiness of Vehicles*", Mechanical Engineering Publications, 2002.
4. Joseph Lemieux, "*Programming in the OSEK/VDX Environment*", CMP Books, 2001
5. OSEK/VDX Environment, AUTOSAR layered software architecture, 2009.

AT710 AUTOMOTIVE HVAC, CABIN COMFORT AND ERGONOMICS 3- 0- 0- 3

History and Development- Health and Safety - Tools and Measuring Systems – Comfort - Pressure and Temperature - Refrigerants and Lubricants - Special Service Tools - Moisture and Moisture Removal - The Refrigeration System - Compressors and Clutches. Compressor Service - System Components and Metering Devices - Electricity and Electronics Review - Electrical Circuits - Control Devices -Case/Duct Systems -Engine Cooling and Comfort Heating - Troubleshooting and Repair.

Applications of HVAC fundamentals to analysis and design of automotive air conditioning systems. Psychometrics, passenger thermal comfort, refrigeration cycles and system design, central and Unitary systems, heating system design, air flow circuits, Air cleaning, ventilation, air space diffusion, compact heat exchanger design, controls and instrumentation. Cabin comfort - In-car air conditioning - overall energy efficiency - air management.

TEXT BOOKS/REFERENCES:

1. Boyce Dwiggins, "*Automotive Air Conditioning*", Delmar Cengage Learning, 2001.
2. Steven Daly, "*Automotive Air Conditioning and Climate Control Systems*", Butterworth Heinemann, 2006.
3. John Haynes, "*Automotive Heating and Air Conditioning Systems Manual*", Haynes
4. Publications, 2000.
5. ASHRAE Handbooks.

AS705 NVH AND REFINEMENT FOR AUTOMOTIVE APPLICATION 3-0-0-3

Fundamentals of vibrations - vibration measurement - Vibration response vibration test - Measuring complex elastic modulus - Vibration isolation - The vibration absorber – case studies. Random data and process and Correlation - Fourier series - Spectral density analysis - Relationship between correlation functions and spectral density functions - Linear systems - Weighting functions - Frequency response functions. Random signal processing and spectrum analysis in vehicle noise and vibration refinement.acoustical waves, sound propagation and intensity, instruments for vibration and noise, Noise and Vibration characteristics in a ground vehicle – Measurement and analysis.

Theory of modal analysis - Methods for performing modal analysis - Mid– and high-frequency problems in vehicle noise – statistical energy analysis and wave approaches – simulation and experimental techniques. Aerodynamic noise and its refinement in vehicles - Aerodynamic noise sources - background - Causes of hydrodynamic pressure fluctuations and reduction –Aero-acoustic measurement techniques and psychoacoustic analysis. Active noise and vibration control in vehicles - Future trends.

TEXT BOOKS/REFERENCES:

1. Xu Wang, "*Vehicle Noise and Vibration Refinement*", CRC Press Publication, 2010.
2. Ronald L.Huston, "*Principles of Vibration Analysis with Applications in Automotive Engineering*", SAE International Publication, 2010.
3. Harris C W, "*Shock and Vibration Handbook*", McGraw-Hill, 2006.

AT614 AUTOMOTIVE EMISSIONS AND CONTROL 3- 0- 0- 3

Exhaust emissions - Nitrogen Oxides, Carbon Monoxide, Unburned Hydrocarbon – Their formation and chemistry. Other emissions – Particulate, Crankcase, Evaporative, Refueling. Emission Regulations - Emissions Measurement and Testing Procedures of two/three wheelers, light duty vehicles and Heavy-duty Vehicle Engines, Vehicle Emission Factors. In-use vehicles emission testing. Technology for Controlling Emissions for different Engine Types - Exhaust Gas Treatment, Catalytic Converters, Thermal Reactors, Particulate Traps. Emission Control Options and Costs. Controlling Emissions from In-Use Vehicles.Emission Standards for Inspection and Maintenance Programs.Remote Sensing of Vehicle Emissions: Operating Principles, Capabilities, and Limitations. Fuel Options for Controlling Emissions.

TEXT BOOKS/REFERENCES:

1. Heywood J B, "*Internal Combustion Engine Fundamentals*", McGraw Hill International, 1993.
2. Colin Ferguson R., "*Internal Combustion Engines*", John Wiley and Sons, 1989.
3. Asif Faiz, Christopher and S.Weaver, "*Air Pollution from Motor Vehicles: Standards and Technologies for Controlling Emissions*" World Bank Publication, 2000.

AS706 AUTOMOTIVE INFOTAINMENT 3- 0- 0- 3

Introduction to an Infotainment System - Design considerations - EMI/EMC compliance - Tuner technology - Text-to-speech, Gesture & Voice recognition - Touch screen - Rear View Display - Lane Departure Warning, Steering wheel control - Head-up display - GPS, GNSS: Connectivity/integration possibilities and implications – Wifi – Bluetooth - USBH + USBF - SD-Card - Mobile broadband - Smartphone integration - Automotive bus protocols, Infotainment System Architecture - System block diagram: Hardware, OS, Middleware layer - HMI layer - Small memory footprint - Infotainment from a platform perspective - SoC, HW IP, Multicore, DMIPS capability, RAM, Flash requirement, Volatile & Non-volatile memory technology, Most dominant IOs, Bandwidth requirement from IOs like: External bus - DDR3 - Role of a Hypervisor: Application - RTOS partition: Rear view camera, Digital Radio, Audio, Video playback, Cell phone hands free - GPOS(Embedded Linux) partition - OS layer – Proprietary, Open Source RTOS - Hard & Soft Real time Process - From AUTOSAR to Gen VI, Middleware layer - Connectivity to device: iPhone, iPod, iPad, Android devices, MTP, Media Players, Smartphones, Thumb drives - USB, Bluetooth, Wi-Fi, 3G, 4G, iPod Out - Connectivity with application – Navigation - Data formats: GDF, PSF, OSM - Route guidance algorithm - Media Player – Browser - Application layer.

TEXT BOOKS/REFERENCES:

1. Ronald K Jurgen, "*Infotainment Systems on Fast Forward*", SAE International, 2007.
2. Dennis, "*Automotive Telematics: The One-stop Guide to In-vehicle Telematics and Infotainment Technology and Applications*", Red Hat Publishing, 2002.